

Particular applications of infrared thermography temperature measurements for diagnostics of overhead heat pipelines

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Extended Abstract

Application of the infrared thermography technique for examination of thermal insulation of the overhead heat pipelines is a very effective and modern technology. The result of the temperature thermovision measurement is influenced by many parameters, especially by emissivity of the examined surface and the temperature of the surrounding elements. Convective and radiative heat transfer takes place between thermal pipelines and its surrounding [2]. Generally, the surrounding of the external overhead pipeline consists of two surfaces: hypothetical sky surface and ground surface [1]. Normally, the temperatures of these elements are different. In the case of low temperature of the sky, due to very intensive radiative emission of the heat, the temperature of some parts of the pipeline shell may drop below the temperature of the atmosphere [1]. This phenomenon has been confirmed by calculations carried out by means of CFD Fluent. The aforementioned phenomenon causes difficulties during evaluation of the quality of the thermal insulation of the pipeline and determination of the pipeline heat losses.

Examples of such phenomena can be seen in Fig. 1. Temperature values in these points are printed near the crosses which can be found on the external surface of the pipelines (Fig. 1). It can be noticed that the temperature of the shell on the upper part of the pipelines is lower than the temperature of atmospheric air.

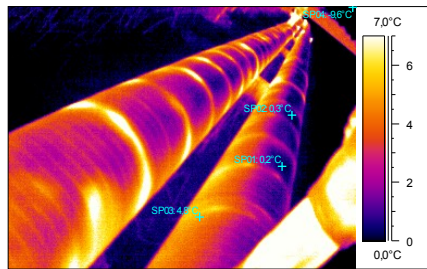


Fig. 1. Example of results of infrared thermography examination of heat pipeline; $T_{Atm}=4.5^{\circ}\text{C}$, $T_{Sk}=-9.6^{\circ}\text{C}$, SP01: 0.2°C , SP02: 0.3°C , SP03: 4.8°C

In order to examine this phenomenon the laboratory measurements have been carried out. Additionally, in the analysis of heat exchange between the pipeline and its surrounding the package CFD Fluent has been applied [1]. The package of CFD makes it possible to carry out numerical analysis or simulation of processes connected with fluid flow, heat flow processes and other processes. This is achieved by the numerical solution of equations describing these phenomena.

The calculation results are presented in Fig. 2. The wall temperature of pipeline was equal to 473 K, outer diameter of the tube without thermal insulation was equal to 273 mm and thickness of thermal insulation 100 mm.

Fig. 2 presents the distributions of the shell temperature around the pipeline. Fig 2a deals with shell emissivity of 0.2. This value is characteristic of new metal shells although such pipelines are usually not examined. The typical shell emissivity of the pipeline with old shell amounts to about 0.9; see Fig. 2b. Strong diversification of the shell temperature between the upper and bottom part of the pipeline, denoted by ΔT_s , can be observed in this case. In order to calculate properly the heat losses in this case in order to evaluate the quality of thermal insulation, this phenomenon should be taken into consideration.

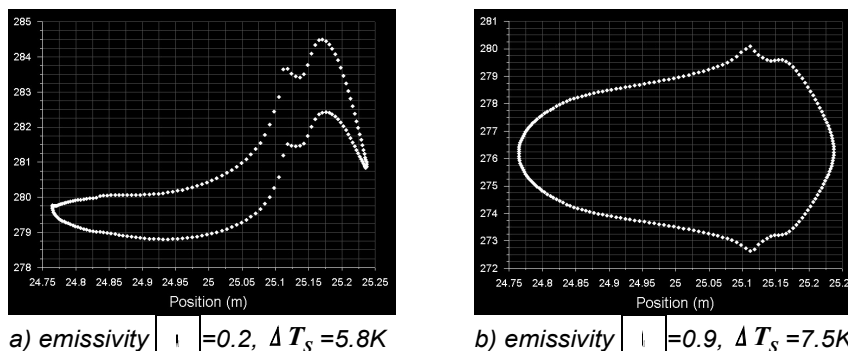


Fig. 2. Distributions of the temperature of the shell around the pipeline for various values of emissivity of the shell and wind velocity 1.0 m/s; horizontal axis – position along wind way (position = 25m – vertical symmetry axis of the pipeline), vertical axis of diagram – temperature of the pipeline shell

Knowledge of the temperature of the pipeline shell makes it possible to calculate locally the heat losses from the pipeline. Determination of the heat losses makes it possible to evaluate the quality and technical state of thermal insulation of the pipeline.

Unfortunately, the results of infrared examination of the pipelines are influenced by many parameters. The most important parameters are the emissivity of the protective shell, the temperature of the sky and wind velocity occurring during the thermovision examination of the pipeline.

The mechanisms of the influence of various parameters were recognized and confirmed by laboratory examination. It is possible to take into account all measurement circumstances and make necessary corrections of measurement results in order to draw proper conclusions concerning the quality of pipeline thermal insulation.

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